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R&D Progress of the Divertor Material/Component Testing Facilities of CRAFT

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ABSTRACT

- Conceptual design and machine design phases of a large linear plasma facility and a high heat flux (HHF) test device have been finished.
- A prototype linear plasma machine employing conventional water-cooled magnets has been constructed which can maintain a steady-state magnetic field strength of ~0.8 T and test various new high-density plasma sources with particle flux up to10^{23}-10^{24} $m^{-2}s^{-1}$.
- A pilot HHF device has been built for qualifying new EAST PFCs and testing relevant HHF instrumentations.

BACKGROUND

- To support the R&D of China Fusion Engineering Test Reactor (CFETR) [1], a Comprehensive Research Facility for Fusion Technology (CRAFT) program has been launched at the Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP).
- Within the CRAFT program, a divertor material/component testing project is authorized to address some key R&D issues of plasma-facing materials and components for CFETR in appropriate physical regimes, size and time scales of plasma-material interactions.
- This project includes two user-facilities: a large linear plasma machine and a high heat flux (HHF) test device. The project started from September 2019 and is scheduled to be completed in 2024.

MACHINE PARAMETERS

Large linear plasma testing facility (Fig. 1(a))

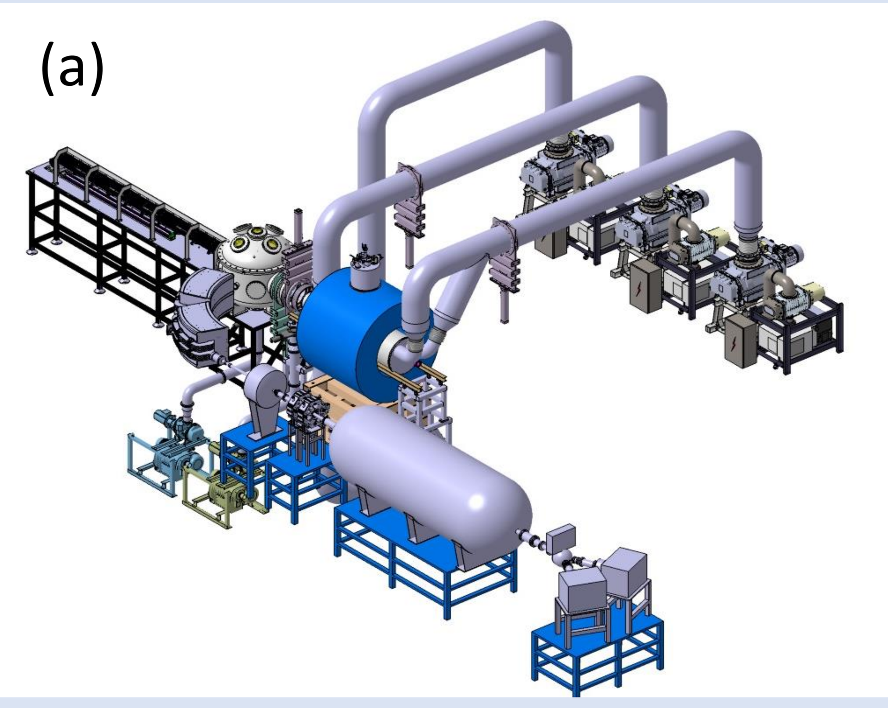
Table 1. Machine parameters

Shot length	>1000 s
Particle flux	>1×10^{24} $m^{-2}s^{-1}$
Magnetic field	>3 T

- The baseline plasma diagnostics include Thomson scattering, emission spectrum and target probes.
- In-situ tools for material analysis like laser-induced breakdown spectroscopy (LIBS), ion beam analysis (IBA) and thermal desorption spectroscopy (TDS) will be installed.

High heat flux test facility (Fig. 1(b))

- It is equipped with two electron beam guns (60 kW@120 kV and 800 kW@60 kV) and the maximum scanning area is ~1 m^2.
- This HHF facility will be connected to high temperature high pressure water and helium loops.



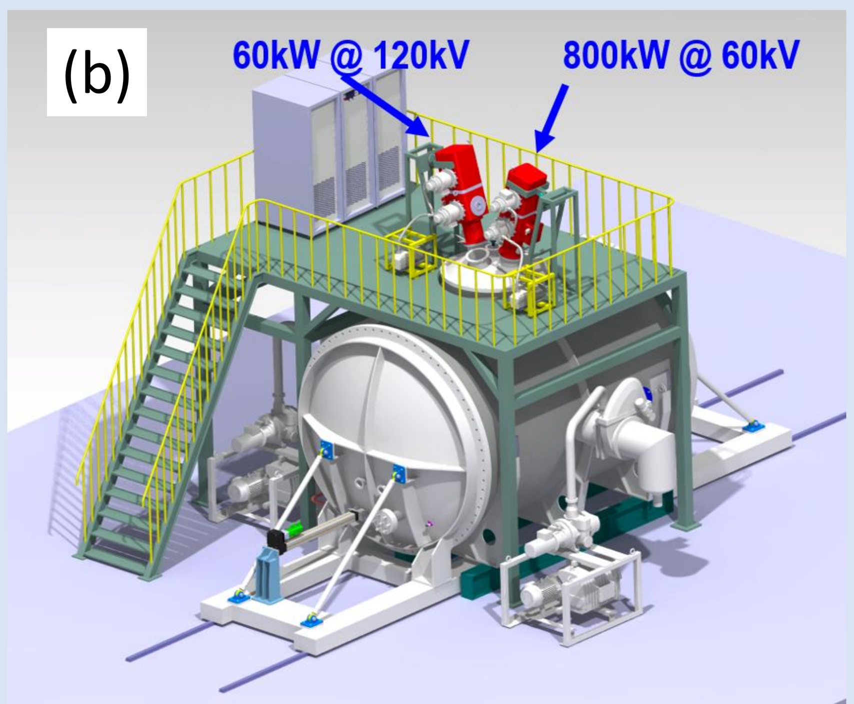


FIG. 1. Drawings of (a) the large linear plasma testing facility and (b) the HHF test facility.

R&D PROGRESS

Prototype linear plasma machine

- A source testing platform (Fig. 3(a)) is developed at ASIPP. As a compact machine for source testing purpose, this linear plasma device is able to maintain relatively high steady-state magnetic field strength (0.8 T) with cost-effective copper magnets.
- Realtime ion flux measurement is available by utilizing a water-cooled target probe.
- With a relatively low fluid conductance (small vacuum chamber), high flux (~0.5×10^{24} $m^{-2}s^{-1}$) steady-state experiments are performed successfully.

Pilot high heat flux test facility

- A HHF device (Fig. 3(b)) equipped with a 100-kW electron gun is built to qualify new EAST PFCs [2] and to test relevant HHF instrumentations.

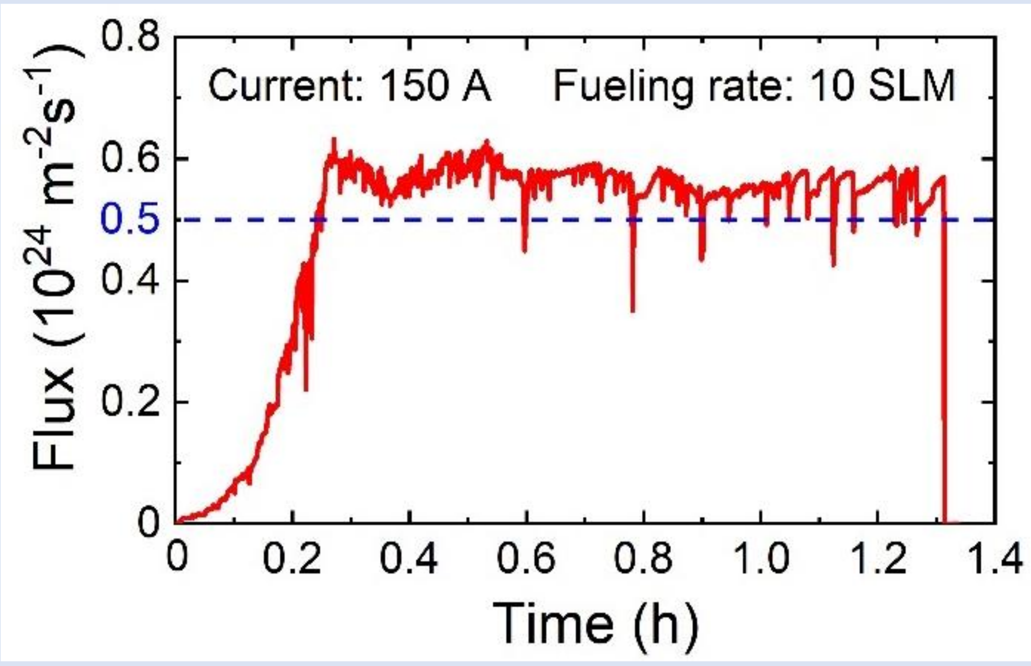
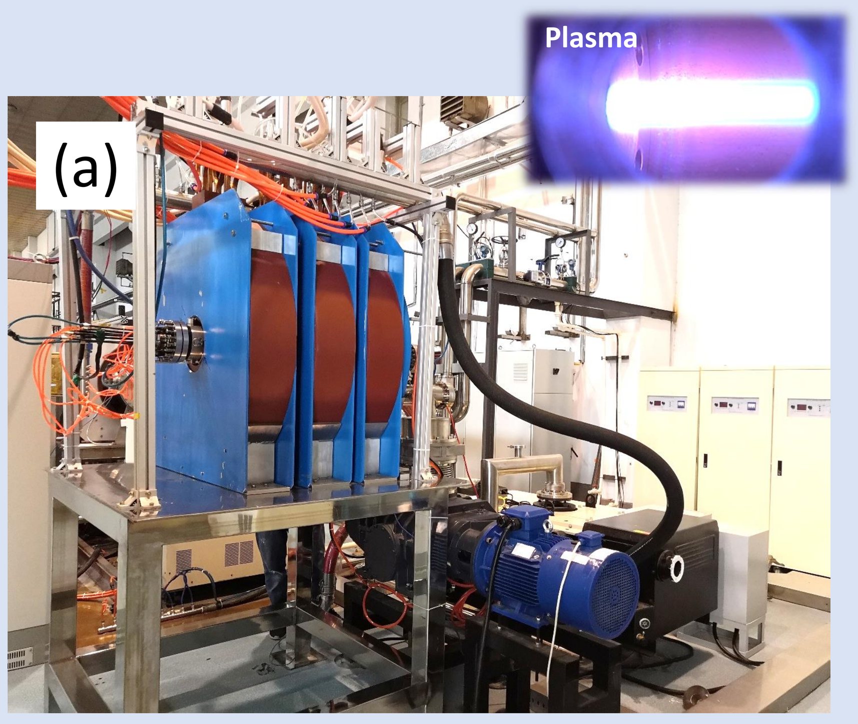


FIG. 2. 1-hour plasma discharge with an ion flux of ~0.5×10^{24} $m^{-2}s^{-1}$ obtained in the prototype linear plasma machine. The working gas is argon.



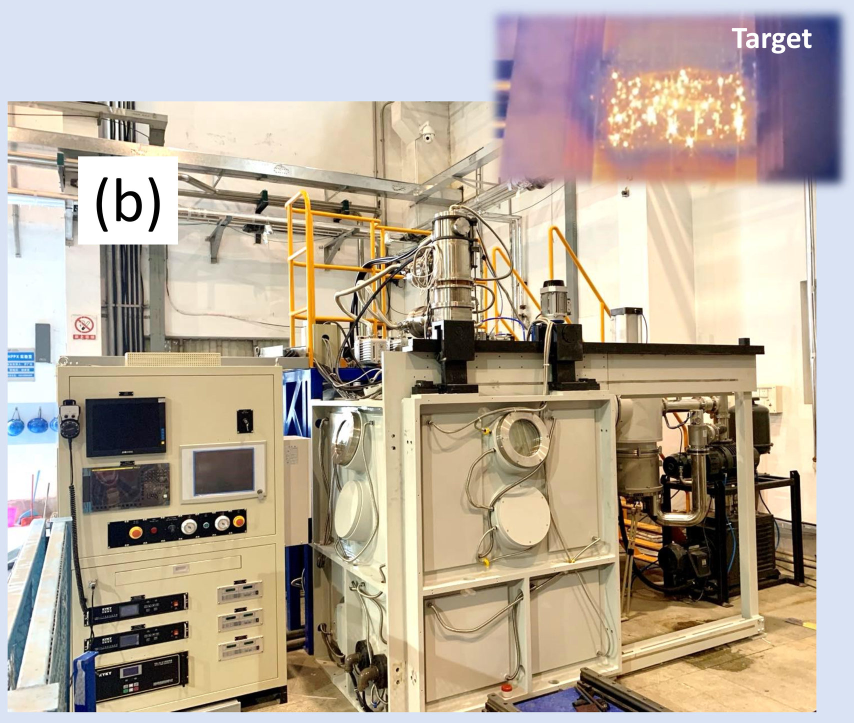


FIG. 3. Pictures of (a) the prototype linear plasma machine and (b) the pilot 100-kW HHF test facility at ASIPP.

CONCLUSION

- The design work of the large linear plasma machine and the HHF test device of CRAFT project has been finished.
- A prototype linear plasma machine and a polit HHF test facility are successfully commissioned.
- The facilities will provide new research opportunities for users in the whole PMI research community.

ACKNOWLEDGEMENTS / REFERENCES

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[1] G. Zhuang et al., Nucl. Fusion 59 (2019) 112010.
[2] G.-N. Luo et al., Nucl. Fusion 57 (2017) 065001.